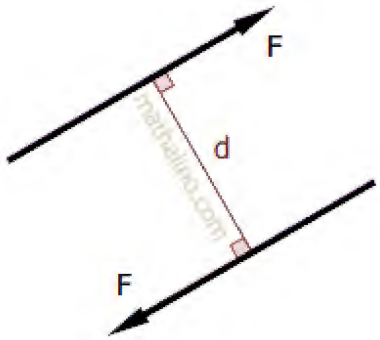
Couples

Couple is a system of forces whose magnitude of the resultant is zero and yet has a moment sum. Geometrically, couple is composed of two equal forces that are parallel to each other and acting in opposite direction. The magnitude of the couple is given by

$$C = Fd$$

Where F are the two forces and d is the moment arm, or the perpendicular distance between the forces.



Couple is independent of the moment center, thus, the effect is unchanged in the following conditions.

- The couple is rotated through any angle in its plane.
- The couple is shifted to any other position in its plane.
- The couple is shifted to a parallel plane.

In a case where a system is composed entirely of couples in the same plane or parallel planes, the resultant is a couple whose magnitude is the algebraic sum of the original couples.

Problem 245

Refer to Fig. 2-24a. A couple consists of two vertical forces of 60 lb each. One force acts up through A and the other acts down through D. Transform the couple into an equivalent couple having horizontal forces acting through E and F.

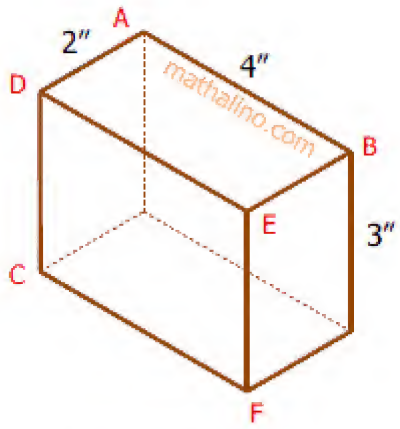
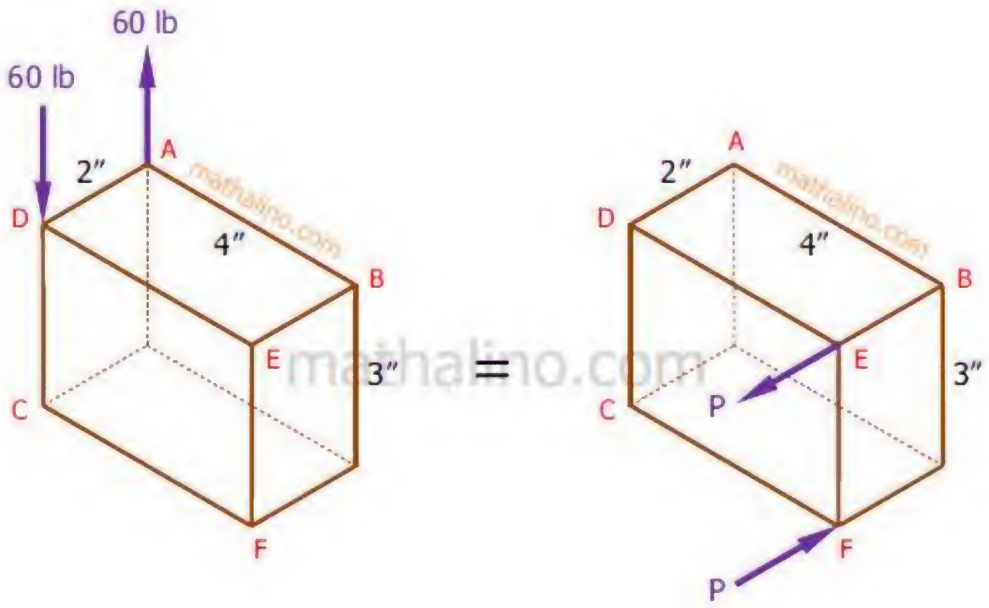


Figure 2-24a

$C = 2(60)$

$C = 120 \text{ lb} \cdot \text{in}$



$3P = C$

$3P = 120$

$P = 40 \text{ lb}$ *answer*

EXAMPLE 4.10

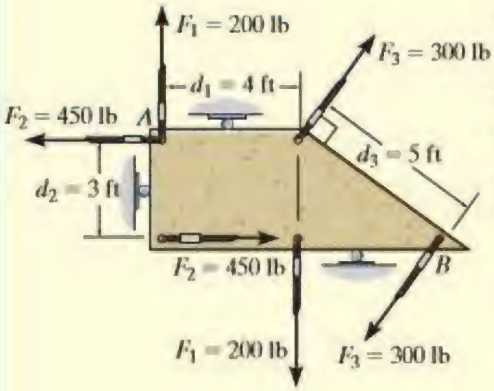


Fig. 4–30

Determine the resultant couple moment of the three couples acting on the plate in Fig. 4–30.

SOLUTION

As shown the perpendicular distances between each pair of couple forces are $d_1 = 4$ ft, $d_2 = 3$ ft, and $d_3 = 5$ ft. Considering counterclockwise couple moments as positive, we have

$$\zeta + M_R = \Sigma M;\ M_R = -F_1 d_1 + F_2 d_2 - F_3 d_3$$

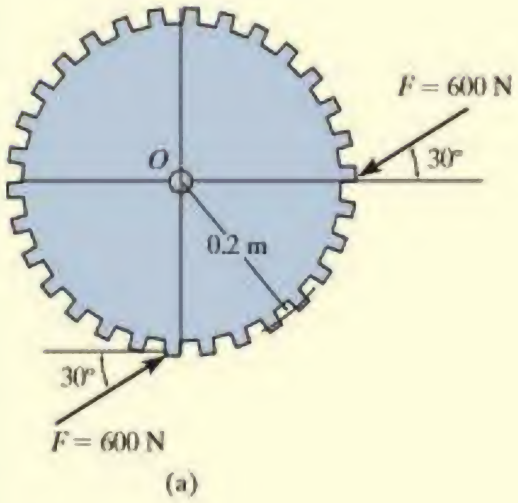
$$= -(200\text{ lb})(4\text{ ft}) + (450\text{ lb})(3\text{ ft}) - (300\text{ lb})(5\text{ ft})$$

$$= -950\text{ lb}\cdot\text{ft} = 950\text{ lb}\cdot\text{ft}\ \circlearrowright \qquad \textit{Ans.}$$

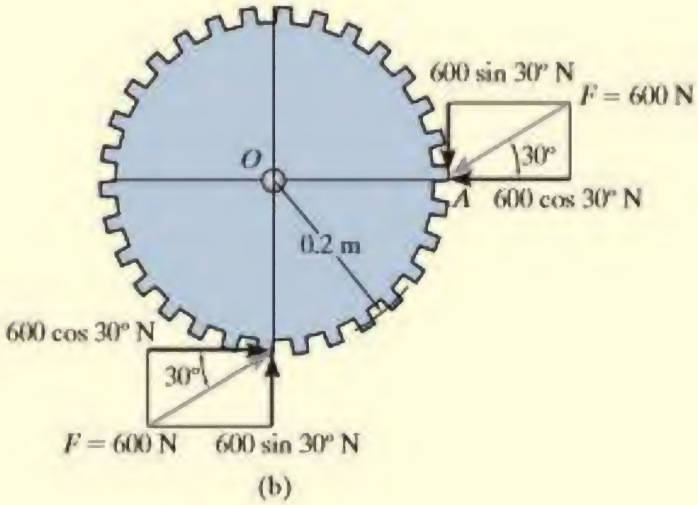
The negative sign indicates that $\mathbf{M}_R$ has a clockwise rotational sense.

EXAMPLE 4.11

Determine the magnitude and direction of the couple moment acting on the gear in Fig. 4–31*a*.



(a)



(b)

SOLUTION

The easiest solution requires resolving each force into its components as shown in Fig. 4–31*b*. The couple moment can be determined by summing the moments of these force components about any point, for example, the center O of the gear or point A. If we consider counterclockwise moments as positive, we have

$$\zeta + M = \Sigma M_O;\ M = (600\cos 30°\text{ N})(0.2\text{ m}) - (600\sin 30°\text{ N})(0.2\text{ m})$$

$$= 43.9\text{ N}\cdot\text{m}\ \circlearrowleft \qquad \textit{Ans.}$$